Sagavanirktok River Particle Size Distributions

Prepared for
Alaska Department of Transportation and Public Facilities

Prepared by
Ken Tape, Jason Clark, and Horacio Toniolo
Water and Environmental Research Center
Institute of Northern Engineering
University of Alaska Fairbanks
Fairbanks, AK 99775

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Front cover photo:

Jason Clark pulling the jet boat up on a gravel bar of the Sagavanirktok River during sampling. (Photo by Ken Tape)

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For additional information, write to:

Publications
Water and Environmental Research Center
Institute of Northern Engineering
University of Alaska Fairbanks
Fairbanks, AK 99775
http://ine.uaf.edu/werc

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Disclaimer

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INTRODUCTION

The Alaska Department of Transportation and Public Facilities (ADOT&PF) has been exploring the possibility of extracting gravel for road construction and maintenance from the Sagavanirktok River floodplain. The goal of this project was to sample the Sagavanirktok River floodplain sediments and produce relationships that predict particle sizes. The research team traveled the Sagavanirktok River by jet boat from Dalton Highway milepost 326 (USGS gauge site) to milepost 406, stopping approximately every mile to take 2 to 8 vertical pictures of gravel bars. We, used high-resolution GPS to record locations, and later converted images to particle size distributions using automated software. To inform ADOT&PF material site selections, we used collected data to show predicted particle sizes associated with Dalton Highway mileposts within the study domain. All project data collected are archived in accessible and usable formats, including tables, regressions predicting particle size, and particle size visualizations in Google Earth.

METHODS

The research team spent approximately one week in late August 2017 collecting data along the Sagavanirktok River. We anticipated difficulties traveling the Sagavanirktok River by jet boat at low water levels, a condition that results from diminished glacial melt as the summer season wanes. Due to having to navigate whitewater and boulder gardens in the river between the USGS gauge site (milepost 326) and Happy Valley (milepost 335), we decided to start the sampling at Happy Valley and proceed downstream. Upon reaching milepost 406, we trailered the boat back to milepost 326 and boated from there to Happy Valley, completing the length of the study area. Jet boats should be used with great caution on this upper section of the Sagavanirktok River. Having gained experience on the lower parts of the river, we found it manageable. Strong headwinds on lower sections of the river necessitated a powerboat, though shallow water and aforementioned obstructions made navigation challenging.

We stopped to take measurements on gravel bars every 3 minutes (approximately 1 mile). In preparation for this fieldwork, we constructed a PVC frame that served as a scale bar for reliably

and repeatedly positioning the Canon digital camera a fixed distance from the riverbed surface for image acquisition. At each sandbar, we acquired 2 to 8 vertical images using the PVC frame mount. We attempted to sample homogeneous areas of sediments representative of the sandbar; we did not sample randomly.

Using a Trimble 5700 survey grade rover GPS, we recorded a high-resolution differential location for each image. Post-processing by Randy Fulweber at Toolik Lake Field Station to remove satellite error increased the precision to <1 cm in the horizontal direction and <2 cm in the vertical direction. Images were processed using Hydraulic Toolbox 4.2 software (Federal Highways Administration [2014], https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox404.cfm), which produced particle size distributions for each image. These distributions were averaged for each gravel bar stop.

RESULTS

Results show decline in all particle sizes with distance downstream along the Sagavanirktok River (Figure 1, Table 1). The steepest decline was observed for the largest particles, d100, which average approximately 9 inches at the uppermost sites and decrease to 5.5 inches near the coast. On average, d85 declines from approximately 5 inches to 3 inches; d50 declines from approximately 3 inches to 2 inches; d15 declines from 1.5 inches to 1 inch; and d5 declines from 1 inch to 0.6 inch (Figure 2). These data are contained in an Excel file (SagGravelGradations.xls). Predicted particle size values can be calculated by inputting mileposts to linear regression equations for the desired particle distributions (Figure 2, Table 2), or by referencing the Excel file table that contains this information (SagGravelRegression.xls).

This report includes a file (SagPhotos.kml) that contains all the geotagged images (n = 218) along the Sagavanirktok River. In this kml format, one can quickly see what actual sediments look like at all sampled locations scattered along the reach by browsing the sediment images in Google Earth (Figure 3). The image thumbnails and image files must be stored in the same folder as the kml file to view the images. A single image represents each stop where we acquired imagery. By clicking on an image, one can see the 2 to 8 images of sediments collected at that location. The locations of all images collected are also included in the file SagPhotos.xls.

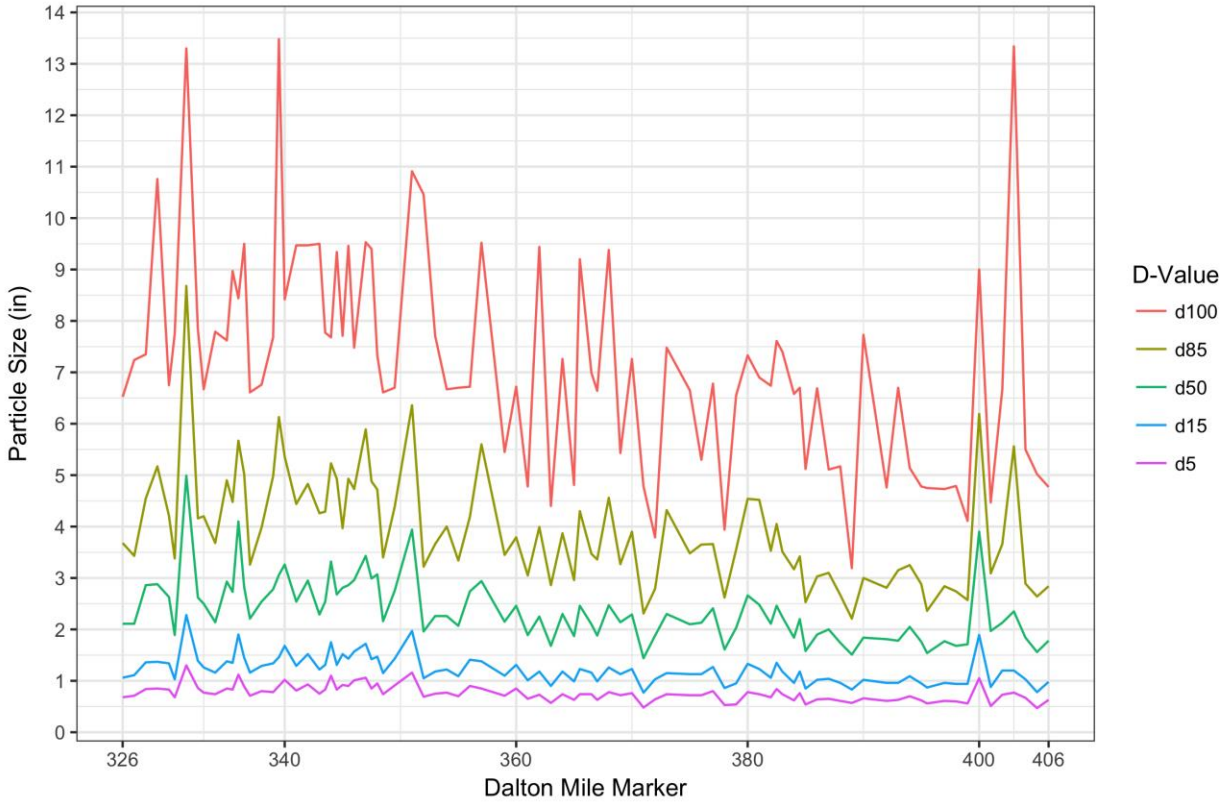

Figure 1. Particle size density as derived from images of gravel bars along the Sagavanirktok River, corresponding to Dalton Highway mileposts.

Table 1. Particle size density averages calculated from multiple images along the Sagavanirktok River, corresponding to Dalton Highway mileposts.

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
326	0.68	1.06	2.11	3.68	6.52
327	0.71	1.11	2.11	3.43	7.24
328	0.84	1.36	2.86	4.55	7.35
329	0.85	1.37	2.88	5.17	10.76
330	0.83	1.34	2.63	4.21	6.75
330.5	0.68	1.03	1.89	3.38	7.75
331.5	1.3	2.28	4.99	8.68	13.3
332.5	0.86	1.39	2.62	4.16	7.83
333	0.77	1.26	2.5	4.2	6.67

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
334	0.74	1.16	2.14	3.68	7.79
335	0.85	1.38	2.93	4.9	7.62
335.5	0.83	1.35	2.73	4.48	8.97
336	1.12	1.9	4.1	5.67	8.44
336.5	0.89	1.45	2.82	5.02	9.5
337	0.71	1.16	2.21	3.26	6.61
338	0.8	1.29	2.54	3.98	6.76
339	0.78	1.34	2.78	4.98	7.68
339.5	0.9	1.46	3.06	6.13	13.48
340	1.02	1.68	3.26	5.36	8.42
341	0.81	1.29	2.54	4.44	9.47
342	0.93	1.52	2.95	4.83	9.47
343	0.75	1.22	2.29	4.26	9.5
343.5	0.83	1.31	2.54	4.29	7.77
344	1.1	1.75	3.32	5.23	7.68
344.5	0.83	1.31	2.68	4.93	9.34
345	0.92	1.52	2.81	3.97	7.71
345.5	0.9	1.43	2.86	4.93	9.46
346	1.01	1.57	2.96	4.73	7.48
347	1.06	1.72	3.43	5.89	9.53
347.5	0.85	1.42	2.99	4.88	9.4
348	0.95	1.47	3.07	4.72	7.33
348.5	0.74	1.15	2.16	3.4	6.61
349.5	0.91	1.43	2.75	4.38	6.7
351	1.16	1.97	3.94	6.36	10.91
352	0.69	1.05	1.96	3.22	10.46
353	0.75	1.18	2.26	3.66	7.71
354	0.77	1.22	2.26	4.0	6.67
355	0.7	1.09	2.07	3.34	6.7
356	0.9	1.41	2.74	4.19	6.72
357	0.85	1.38	2.94	5.6	9.52
359	0.71	1.1	2.15	3.45	5.45

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
360	0.85	1.31	2.46	3.79	6.72
361	0.65	1.01	1.89	3.05	4.78
362	0.73	1.18	2.25	3.99	9.44
363	0.57	0.9	1.68	2.86	4.4
364	0.74	1.18	2.3	3.87	7.26
365	0.63	0.99	1.87	2.96	4.81
365.5	0.74	1.23	2.46	4.3	9.2
366.5	0.74	1.16	2.1	3.47	6.99
367	0.63	0.99	1.88	3.36	6.64
368	0.78	1.26	2.47	4.56	9.38
369	0.72	1.13	2.14	3.27	5.43
370	0.76	1.23	2.29	3.9	7.26
371	0.48	0.77	1.44	2.31	4.78
372	0.64	1.03	1.88	2.79	3.79
373	0.74	1.15	2.3	4.32	7.48
375	0.72	1.13	2.1	3.48	6.65
376	0.72	1.13	2.13	3.65	5.3
377	0.8	1.27	2.41	3.66	6.78
378	0.53	0.86	1.61	2.62	3.94
379	0.54	0.95	2.03	3.55	6.55
380	0.78	1.33	2.66	4.54	7.33
381	0.74	1.23	2.48	4.52	6.9
382	0.68	1.06	2.11	3.53	6.74
382.5	0.84	1.35	2.46	4.05	7.61
383	0.74	1.18	2.24	3.51	7.4
384	0.62	0.96	1.84	3.17	6.58
384.5	0.76	1.18	2.2	3.42	6.7
385	0.54	0.85	1.58	2.53	5.12
386	0.64	1.02	1.9	3.03	6.69
387	0.65	1.04	2.0	3.1	5.11
388	0.61	0.96	1.74	2.67	5.17
389	0.57	0.83	1.51	2.21	3.19

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
390	0.66	1.02	1.84	3.0	7.73
392	0.61	0.96	1.81	2.81	4.76
393	0.63	0.96	1.78	3.15	6.7
394	0.7	1.09	2.05	3.25	5.14
395	0.62	0.95	1.76	2.88	4.78
395.5	0.56	0.87	1.54	2.36	4.75
397	0.61	0.96	1.77	2.84	4.73
398	0.6	0.94	1.68	2.74	4.79
399	0.56	0.94	1.71	2.57	4.11
400	1.05	1.89	3.9	6.19	9.0
401	0.51	0.88	1.97	3.09	4.47
402	0.73	1.2	2.13	3.66	6.67
403	0.77	1.2	2.35	5.56	13.34
404	0.67	1.03	1.84	2.89	5.5
405	0.47	0.78	1.56	2.64	5.02
406	0.63	0.98	1.78	2.84	4.77

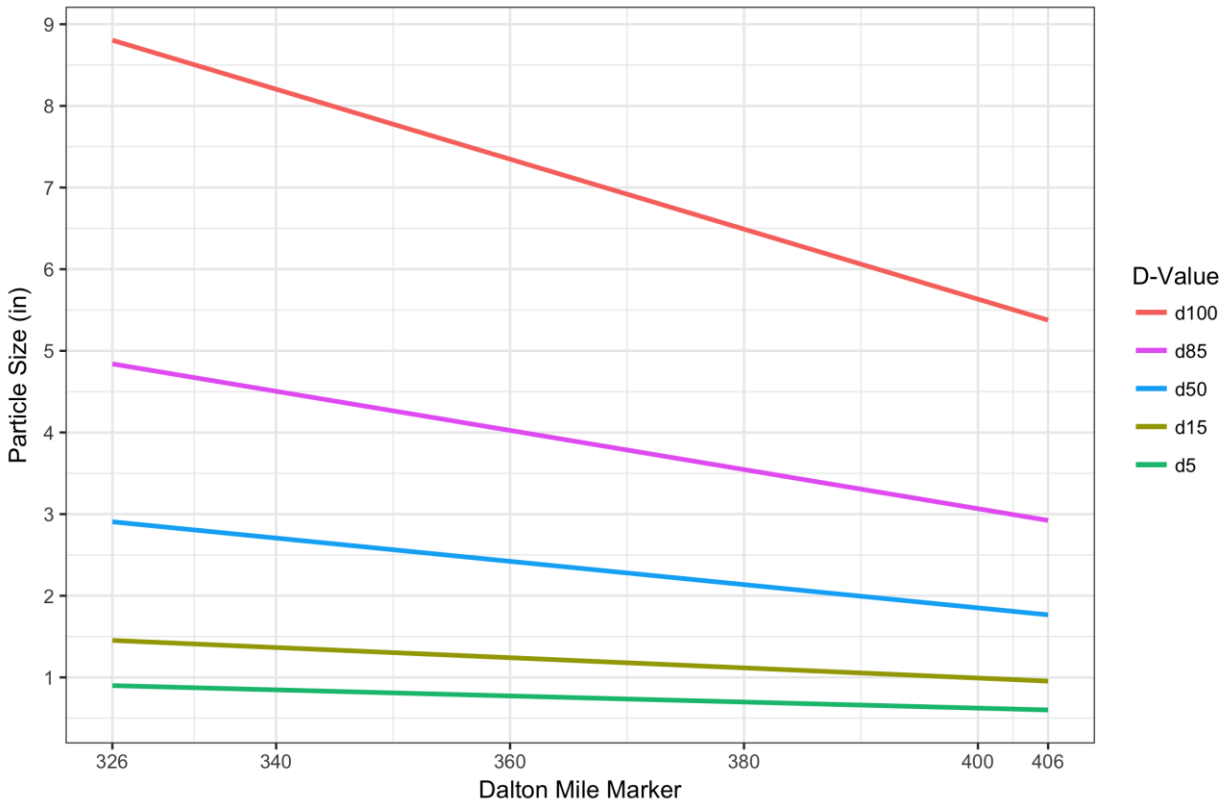

Figure 2. Particle size density as estimated from linear regression of image gradations. Regression equations for particle size densities are d5 = 2.1161 - 0.0037*milepost; d15 = 3.4842 - 0.0062*milepost; d50 = 7.5486 - 0.0142*milepost; d85 = 12.6530 - 0.0240*milepost; and d100 = 22.7747 - 0.0429*milepost. The R^2 for the regression equations is d5 = 0.3138; d15 = 0.2793; d50 = 0.2865; d85 = 0.2605; and d100 = 0.2282.

Table 2. Particle size density as estimated from linear regression of image gradations (see Figure 2 caption for information on regression equations).

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
326	0.90	1.45	2.91	4.84	8.80
327	0.90	1.45	2.89	4.82	8.76
328	0.89	1.44	2.88	4.79	8.72
329	0.89	1.43	2.86	4.77	8.68
330	0.88	1.43	2.85	4.74	8.63
331	0.88	1.42	2.83	4.72	8.59
332	0.88	1.42	2.82	4.70	8.55
333	0.87	1.41	2.81	4.67	8.50
334	0.87	1.40	2.79	4.65	8.46

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
335	0.87	1.40	2.78	4.62	8.42
336	0.86	1.39	2.76	4.60	8.38
337	0.86	1.38	2.75	4.58	8.33
338	0.86	1.38	2.74	4.55	8.29
339	0.85	1.37	2.72	4.53	8.25
340	0.85	1.37	2.71	4.50	8.20
341	0.84	1.36	2.69	4.48	8.16
342	0.84	1.35	2.68	4.46	8.12
343	0.84	1.35	2.66	4.43	8.08
344	0.83	1.34	2.65	4.41	8.03
345	0.83	1.33	2.64	4.38	7.99
346	0.83	1.33	2.62	4.36	7.95
347	0.82	1.32	2.61	4.34	7.90
348	0.82	1.32	2.59	4.31	7.86
349	0.81	1.31	2.58	4.29	7.82
350	0.81	1.30	2.56	4.26	7.78
351	0.81	1.30	2.55	4.24	7.73
352	0.80	1.29	2.54	4.22	7.69
353	0.80	1.29	2.52	4.19	7.65
354	0.80	1.28	2.51	4.17	7.60
355	0.79	1.27	2.49	4.15	7.56
356	0.79	1.27	2.48	4.12	7.52
357	0.78	1.26	2.46	4.10	7.48
358	0.78	1.25	2.45	4.07	7.43
359	0.78	1.25	2.44	4.05	7.39
360	0.77	1.24	2.42	4.03	7.35
361	0.77	1.24	2.41	4.00	7.30
362	0.77	1.23	2.39	3.98	7.26
363	0.76	1.22	2.38	3.95	7.22
364	0.76	1.22	2.36	3.93	7.18
365	0.75	1.21	2.35	3.91	7.13
366	0.75	1.20	2.34	3.88	7.09

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
367	0.75	1.20	2.32	3.86	7.05
368	0.74	1.19	2.31	3.83	7.00
369	0.74	1.19	2.29	3.81	6.96
370	0.74	1.18	2.28	3.79	6.92
371	0.73	1.17	2.27	3.76	6.88
372	0.73	1.17	2.25	3.74	6.83
373	0.72	1.16	2.24	3.71	6.79
374	0.72	1.15	2.22	3.69	6.75
375	0.72	1.15	2.21	3.67	6.70
376	0.71	1.14	2.19	3.64	6.66
377	0.71	1.14	2.18	3.62	6.62
378	0.71	1.13	2.17	3.59	6.58
379	0.70	1.12	2.15	3.57	6.53
380	0.70	1.12	2.14	3.55	6.49
381	0.69	1.11	2.12	3.52	6.45
382	0.69	1.10	2.11	3.50	6.40
383	0.69	1.10	2.09	3.47	6.36
384	0.68	1.09	2.08	3.45	6.32
385	0.68	1.09	2.07	3.43	6.28
386	0.68	1.08	2.05	3.40	6.23
387	0.67	1.07	2.04	3.38	6.19
388	0.67	1.07	2.02	3.35	6.15
389	0.66	1.06	2.01	3.33	6.10
390	0.66	1.05	1.99	3.31	6.06
391	0.66	1.05	1.98	3.28	6.02
392	0.65	1.04	1.97	3.26	5.98
393	0.65	1.04	1.95	3.23	5.93
394	0.65	1.03	1.94	3.21	5.89
395	0.64	1.02	1.92	3.19	5.85
396	0.64	1.02	1.91	3.16	5.80
397	0.64	1.01	1.89	3.14	5.76
398	0.63	1.00	1.88	3.11	5.72

Dalton Hwy Milepost	Particle Size (inches)				
	d5	d15	d50	d85	d100
399	0.63	1.00	1.87	3.09	5.68
400	0.62	0.99	1.85	3.07	5.63
401	0.62	0.99	1.84	3.04	5.59
402	0.62	0.98	1.82	3.02	5.55
403	0.61	0.97	1.81	2.99	5.50
404	0.61	0.97	1.80	2.97	5.46
405	0.61	0.96	1.78	2.95	5.42
406	0.60	0.95	1.77	2.92	5.38

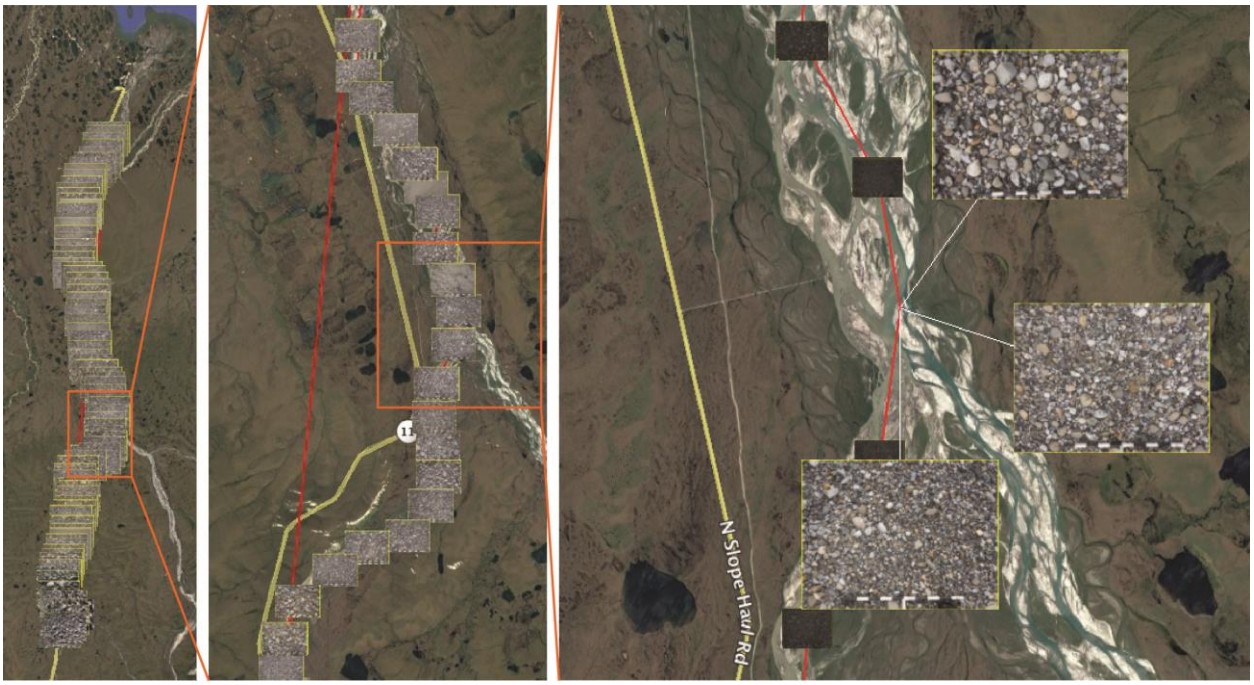

Figure 3. Multi-scalar view of sediment images visualized in Google Earth. The left panel shows the study domain, spanning mileposts 326 to 406 of the Dalton Highway (yellow line underneath images, labeled N Slope Haul Rd in the right panel). The orange boxes denote insets. By clicking on a single image (one site), multiple images acquired at that site can be viewed.


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